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ABSTRACT

Text, illustrations, and exercises are utilized in these four learning modules to teach respiratory therapy students a variety of job-related skills. The first module, "Anatomy and Physiology of the Central Controls of Respiration" by Margot Lavich, describes the functions of the five centers of the brain that control respiration and identifies abnormal breathing patterns that accompany specific respiratory center lesions. The second module, "Troubleshooting an MA-1 Volume Ventilator in Regards to Volume Loss" by Jan L. Yestingsmeier, teaches the therapist to systematically identify and correct the cause of an obstruction, leak, or malfunction of an MA-1 pre-set volume ventilator. The third and fourth modules were prepared by Linda Slater. "How to Perform Oral Endotracheal Intubation on an Adult Manikin" describes equipment and procedures for inserting an endotracheal tube through the mouth, pharynx, larynx, and glottis of a patient after a cardiopulmonary arrest. "Bacterial Surveillance" discusses the conditions and areas favorable to microbeal growth, the ways microbes are carried to patients, two methods of obtaining equipment cultures, and an effective system for bacterial surveillance. Each module details and illustrates procedures, provides sequential reinforcement exercises with immediate feedback, and concludes with a post-test and answer key. The modules take from 25 to 60 minutes each to complete. (JP)

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HEALTH INSTRUCTION PACKAGES:

RESPIRATORY THERAPY

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A PROJECT OF THE LEAGUE FOR INNOVATION IN THE COMMUNITY COLLEGE

ANATOMY AND PHYSIOLOGY OF THE CENTRAL CONTROLS OF RESPIRATION

by

Margot Lavich, B.S., R.R.T.

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TITLE OF PACKAGE:	Anatomy and Physiology of the Central Controls of Respiration
AUTHOR:	Margot Lavich, B.S., R.R.T.
INSTITUTION:	Orange Coast College, Costa Mesa, Calif.
INTENDED STUDENTS:	Respiratory Therapy
LSTIMATED WORKING TIME:	60 minutes
MATERIALS NEEDED:	One practice session requires a partner

FIELD TEST COPY

Note: Knowledge of basic neuro-anatomy and physiology is a prerequsite to effective use of this unit.

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INTRODUCTION

Hold your breath for as long as possible.

Did you finally have to take a breath?

Now, breathe 12 times in one minute; make sure that inspiration is 2 seconds and expiration is 3 seconds.

Rather difficult, isn't it?

Fortunately you don't have to do this 1,440 minutes every day.

It's taken care of for you.

What is it that made you take the breath in the first situation?

What regulates your minute-to-minute respirations?

It's a combination of many things.

1. Respiratory Centers in the brain
2. Central & Peripheral Chemoreceptors
3. Humoral Agents (Po_2, Pco_2, pH)
4. Miscellaneous stimuli (blood pressure, heat)

All of these regulate your respirations.

This package is the first in the series on Regulation of Respiration and deals with the respiratory centers in the brain.

OBJECTIVES OF UNIT

Overall Objective:

After completing this package, you will be able to discuss the normal and abnormal functions of the respiratory control centers.

Sub-Objectives:

1. You will be able to list the anatomical centers in respiratory control.
2. You will be able to describe the normal function of each center and its component parts.
3. From memory, you will draw schematically each center and its components, illustrating the directions of their neural impulses.
4. You will be able to distinguish the breathing pattern that accompanies a specific respiratory center lesion.
5. You will have a chance to write your reactions to this package.

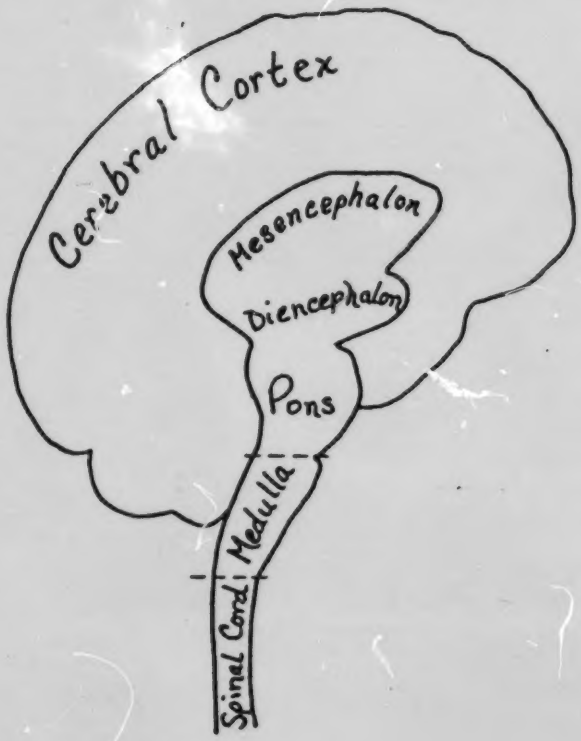


FIGURE 1

LATERAL VIEW OF BRAIN AND BRAIN STEM

PRACTICE EXERCISE # 1

Objective: List the 5 major cerebral centers concerned with control of respiration.

A large number of nerves and many areas in the brain are usually more concerned with your breathing than you are — unless you think about it.

There are 5 main centers in the brain complex that are responsible for the regulation of respiration.

LOOK AT FIGURE 1.

Beginning at the highest level of your brain and moving down, you see:

1. Cerebral Cortex
2. Mesencephalon and Diencephalon
3. Pons
4. Medulla
5. Spinal Cord

Read this list several times.

1) List the 5 centers in the brain concerned with control of respiration, from the highest level to the lowest:

2) List the 5 centers in the brain from the lowest level to the highest.

PRACTICE EXERCISE # 1 (continued)

Feedback

1) If the highest center in your brain, the cerebral cortex, helped you remember the following list, it's doing it's job.

Cerebral Cortex

Mesencephalon & Diencephalon

Pons

Medulla

Spinal Cord

2) Spinal Cord

Medulla

Pons

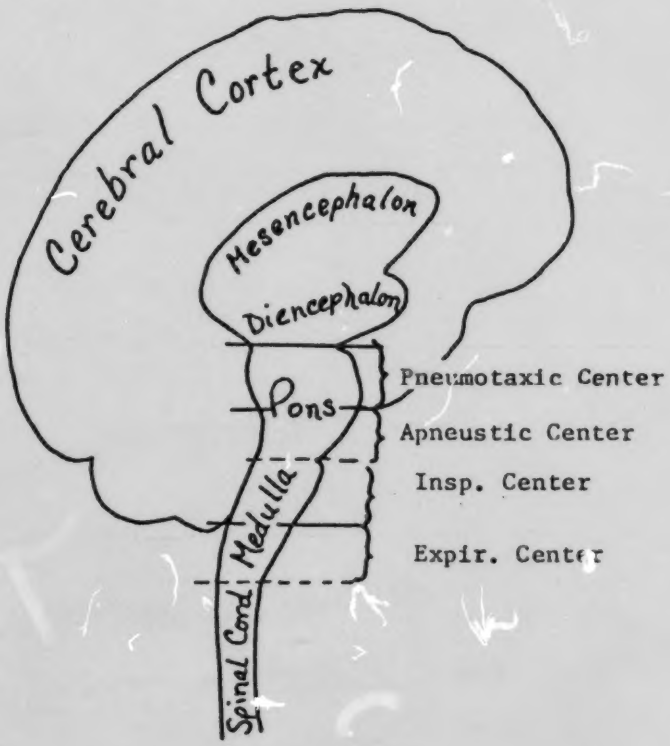
Mesencephalon & Diencephalon

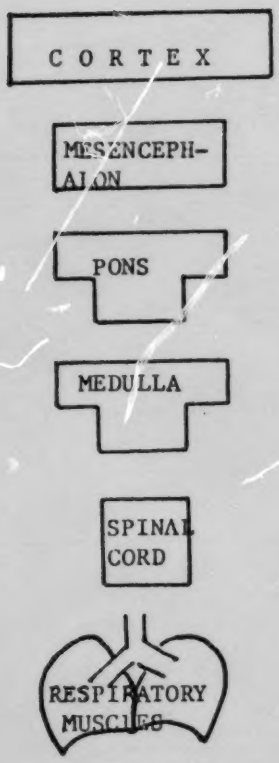
Cerebral Cortex

GOOD!!

You can now proceed to the normal functions of these centers.

FIGURE 2


Cerebral Cortex
Mesencephalon
Diencephalon
Pons
Medulla
Spinal Cord
Pneumotaxic Center
Apneustic Center
Insp. Center
Expir. Center


CORTEX
MESENCEPH-
ALON
PONS
MEDULLA
SPINAL
CORD
RESPIRATORY
MUSCLES

PRACTICE EXERCISE # 2

Objective: You will be able to describe the normal functions of the five respiration centers and their component areas.

Reference to Figure 2 will be helpful in correlating centers and their functions. - Reread information in squares 2 - 3 times.

I. Cerebral Cortex: This center offers the finest, most detailed control of all body functions. In terms of respiration it:

a. gives it normal rhythmicity
b. increases or inhibits respiration rate when certain areas are stimulated.

It does these by sending impulses to the Medulla.

It helps control the length of Inspiration and Expiration.

II. Mescencephalon (midbrain) and Diencephalon (Hypothalmus, thalmus): When stimulated by afferent impulses of heat, arousal, rage, etc. can:

increase respiration rate and volume.

It does this by sending impulses to the Medulla.

Practice Question 2A

1) What relationship is there between the cerebral cortex and control of respiration?

2) If the mesencephalon and diencephalon has neural input of heat or arousal, it will send impulse to what respiratory center?

3) What affect does this impulse from the mesencephalon and diencephalon have on respiration?

Feedback

1) Cerebral Cortex is the highest center of control. It gives the fine rhythmicity we know and love. With correct stimulation it can also increase or decrease respiration rate.
2) Medulla
3) Increases respiratory rate and volume

III. Pons: This center constantly assists the

rhythmicity of inspiration, expiration, inspiration.

It consists of two neural centers.

Pneumotaxic

Apneustic

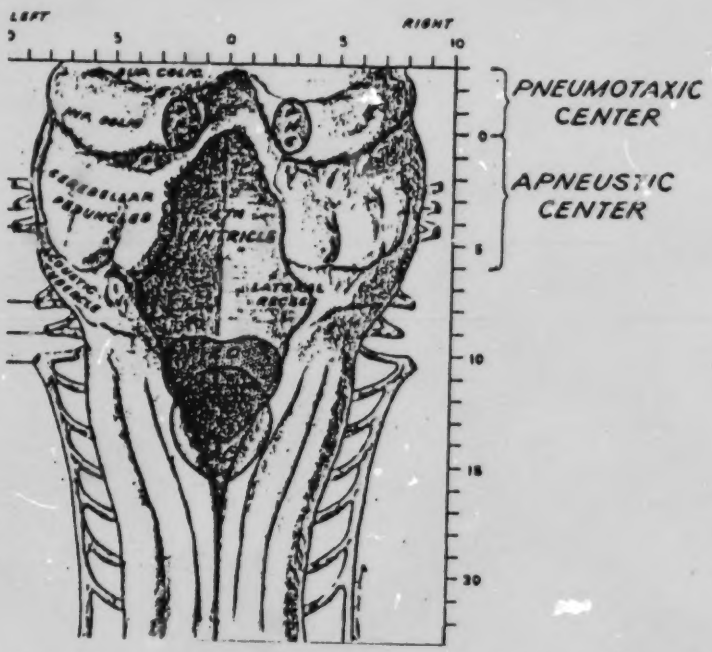


FIGURE 3: DORSAL VIEW OF THE BRAIN SHOWING PONS AND ITS 2 COMPONENT CENTERS.

Pneumotaxic Center: This area along with the Vagus nerve,

periodically inhibits the Apneustic Center
and
activates the Medullary Expiratory Center.

In doing so, it stops inspiration and STARTS EXPIRATION.

Apneustic Center:

This center constantly sends impulses to the Medullary Inspiratory Center.
Thus, initiating inspiration.

Practice Question 2B

1) What center controls the Apneustic Center?

2) This center is concerned with inspiration or expiration? Why?

Feedback

1) Pneumotaxic

2) Expiration. Because it sends impulses to the Apneustic Center to inhibit its impulses to the Medullary Inspiration Center.
It also sends impulses to stimulate the Medullary Expiration Center.

IV. Medulla: This center is the mainstay of this whole operation. No matter what other centers were intact, if you lost your Medulla you would not be able to breathe.
It may be equated with the S-A node or pacemaker of your heart. The medulla sends impulses to your respiratory muscles, no matter what.
It, alone, does not maintain a nice regular rhythm with the right amount of time for inspiration and for expiration. So it does rely on the higher centers to maintain normalcy and to correctly change to meet body demands.
The medulla consists of two centers:

Inspiratory Center

Expiratory Center

Inspiratory Center:

a. sends impulses to the muscles of inspiration

b. receives stimulation from the Apneustic Center

c. sends impulses to the Expiration Center and the Pneumotaxic Center to prepare them for initiation of expiration.

Expiratory Center:

a. Is stimulated by the Pneumotaxic and Inspiration Centers.

b. Sends impulses to the muscles of expiration.

Practice Question 2C

Explain why the medulla is the mainstay of the control of respiration?

Feedback

Medulla will continue to send impulses to the respiratory muscles without higher control.

V. Spinal Cord:

Last but not least, the cord is the pathway through which these finely integrated impulses leave and enter the brain and go to and from the respiratory muscles. Impulses from within the cord also help coordinate the muscles during added workloads, as with singing.

Practice Question 2D

What would be the effect on respiration if no spinal cord were attached to the brain?

Practice Question 2E

Before continuing, go back through this section for review and copy down in two columns:

Respiratory Center (and component areas)	Normal Functions (in squared areas)

Feedback

Permanent Apnea <u>because</u> no impulses can get from brain to muscles.

Respiratory muscle paralysis ensues, also.

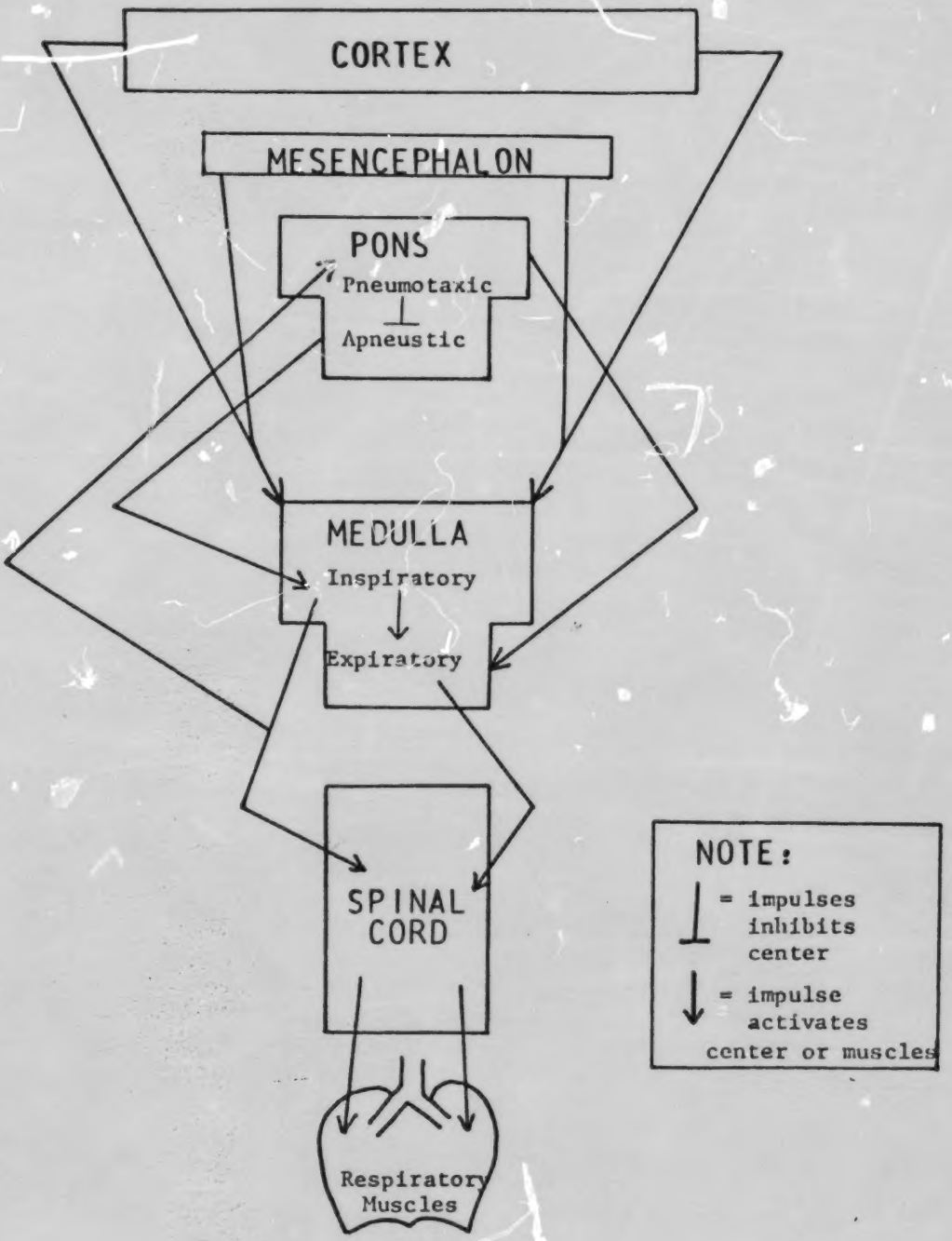
Respiratory Center	Normal Functions
I. Cerebral Cortex	I. Gives normal rhythmicity Increases or inhibits respiration rate.
II. Mesencephalon and Diencephalon	II. Increases respiration rate, volume
III. Pons	III. Rhythmicity
a. Pneumotaxic Center	a. Inhibits apneustic center Activates medullary expiratory center
b. Apneustic Center	b. Constantly sends impulses to the medullary inspiratory center, thus <u>initiating inspiration</u>.
IV. Medulla	IV. Sends impulses to respiratory muscles
a. Inspiratory Center	a. Sends impulses to muscles of inspiration. Receives stimulation from the apneustic center. Sends impulses to expiration center and pneumotaxic center.
b. Expiratory Center	b. Is stimulated by pneumotaxic and inspiration centers Sends impulses to muscles of expiration.
V. Spinal Cord	V. Pathway for impulses to leave and enter brain, go into and from the respiratory muscles.

That was a bit heavy, but you made it.

The following section has a diagram that helps put this section into visual perspective.

PRACTICE EXERCISE # 3

FIGURE 4



Schematic, anatomic representation of the respiratory control centers and their impulse directions.

PRACTICE EXERCISE # 3

Objective: You will be able to draw the schematic in Figure 4 from memory.

To better understand the relationship of these centers to each other, examine Figure 4.

Note each center and the arrows which depict the direction of impulses to and from each center.

After examination, draw below (using Figure 4 for reference):

1. The cortex with arrows showing where it sends its impulses.
2. Insert Mesencephalon and its arrows.
3. Do same for Pons.
4. Insert Medullary Centers.

PRACTICE EXERCISE # 3 (continued)

With a partner, draw the schematics in Figure 4 FROM MEMORY.

Insert appropriate arrows as you verbally explain direction of impulse to your partner.

Your partner should compare your drawing to Figure 4.

If incorrect, redraw and explain again until your partner gives you the O.K. to proceed.

PRACTICE EXERCISE # 4

You're progressing very well!!

In the hospital setting you will see patients who, because of brain tumors or injury, have abnormal breathing patterns.

Let's examine these situations.

Objective: You will be able to distinguish abnormal breathing patterns that accompany specific respiratory center lesions.

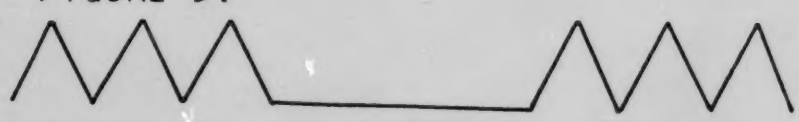
You may know someone with a medullary tumor, or brain damage from an accident or hypoxia, or someone with an injured spinal cord.

Because such injuries or lesions may have hampered normal function of the involved respiratory center, respirations may be abnormal or absent (apnea).

Let's correlate each center with the breathing abnormality seen with a lesion there.

1. Removal or damage of the CEREBRUM usually has little major effect, though if severe may cause TEMPORARY APNEA until the other centers respond and take over. - See Figure 5.

FIGURE 5:



TEMPORARY APNEA

2. Removal or damage to the MESENCEPHALON has no major effect, usually. However, a pattern of gradually increasing respiratory volume followed by gradually decreasing volume may be seen in response to cerebral hypoxia, tumor, or decreased cerebral circulation, seen in cardiac arrest, shock, and congestive heart failure. This pattern is known as CHEYNE-STOKES. See Figure 6. The pattern may have apneic spells interspersed. These usually last less than 20 seconds.

FIGURE 6:

CHEYNE-STOKES

Note clinical situations mentioned above where you'll see this pattern.

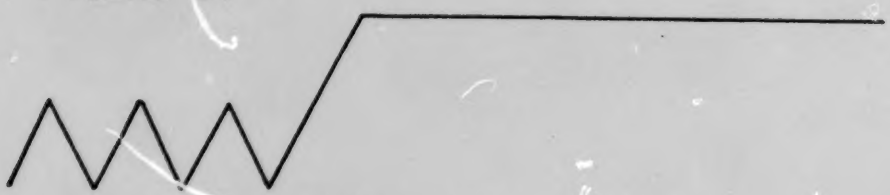
3. Lesions to the upper 1/3 of the Pons leads only to slow, deep respirations, if the Vagus nerves (which send impulses from lung to apneustic center to inhibit it) are intact. See Figure 7.

FIGURE 7:

SLOW, DEEP RESPIRATIONS

4. If there is lesion or damage to the upper 1/3 of Pons and Vagus nerves, a state of continual inspiration is maintained or Apneusis. See Figure 8.

FIGURE 8:



APNEUSIS

5. If the entire Pons is damaged, there is an irregular, non-rhythmic, gasping pattern or Ataxia. See Figure 9.

FIGURE 9:

NON-RHYTHMIC, IRREGULAR GASPS

(ATAXIA)

6. If the Medulla is damaged or has a lesion, no impulses are sent from brain to cord and PERMANENT APNEA results. See Figure 10.

FIGURE 10:

PERMANENT APNEA

7. Naturally, if the Spinal Cord is damaged, respiratory muscle paralysis ensues.

   Depending on location of lesion on cord, a condition occurs where one "forgets" to breathe, especially when asleep.

   This is Ondine's Curse.

8. Next to Cheyne-Stokes, a common pattern seen in brain damage and circulatory abnormalities, Biot's respiration is another frequently seen pattern.

   You will see it in patients with brain damage from hypoxic state, and cerebral infection. It is frequently seen in meningitis.

   Biot's respiration is a series of deep gasps followed by apnea, followed by deep gasps. See Figure 11.

FIGURE 11:

BIOT'S

PRACTICE EXERCISE #4 (continued)

Before going to the practice questions, jot down below the underlined words in this section in two columns. You may copy these, looking back to the last four pages.

Location of lesion	Breathing Pattern
1.	1.
2.	2.
3.	3.
4.	4.
5.	5.
6.	6.
7.	7.
8.	8.

NOTE that the two most common abnormal patterns mentioned in this unit that you'll see are "Cheyne-Stokes" and "Biot's". You need to become proficient in discussing and recognizing these two.

1. What is the difference between a lesion (or damage) to the Cerebrum and to the Medulla, in terms of breathing patterns produced?

2. Why does respiratory muscle paralysis occur when the spinal cord is damaged?

3. Without the direct discipline of the entire Pons on the Medulla, what breathing pattern occurs?

4. The Pons and the Vagus nerve periodically inhibit the Apneustic Center. If damage occurs to these both, describe and label the breathing pattern produced.

5. Hypoxia and/or decreased cerebral blood flow, especially to the mesencephalon causes abnormal respirations. Describe and label the pattern produced.

6. Biot's Respiration is seen to occur many times in patients with brain death or meningitis. What distinguishes this pattern from Cheyne-Stokes?

Feedback

1. Damage to the cerebrum causes temporary apnea.
   Damage to the medulla causes permanent apnea.

2. Since the spinal cord is the pathway through which neural impulses must travel to reach the muscles, severage is equivalent to a road block.

3. Irregular, non-rhythmic, gasps or atoxia.
   * Remember: Medulla can send impulses to muscles without any higher control. But it'll be much more spastic than we are used to.

4. Apneusis. The respiratory cycle will stop in the inspiratory phase.

5. Cheyne-Stokes. A cycle of gradually increasing respiration volume followed by gradually decreasing volume. Periods of apnea less than 20 seconds may occur.

6. Biot's does not have the crescendo, decrescendo pattern that Cheyne-Stokes has. It is a series of uniformly deep gasps always followed by apnea.

POST-TEST

1. List the 5 major divisions of the CNS that have influence on the regulation of respiration.

2. The medulla consists of what 2 respiratory centers?

3. The apneustic and pneumotaxic centers are located in which division?

4. In what ways do the following function for normal control of respiration?

   A. Cerebral Cortex

   B. Mesencephalon, Diencephalon

   C. Pons

   D. Pneumotaxic

   E. Apneustic

   F. Medullary centers

   G. Spinal cord

5. Draw a schematic showing the anatomical position within CNS of the areas listed in question 4. Include arrows showing directions of impulses to and from each center.

6. A patient comes into the Emergency Room from an auto accident. His skull is severely lacerated in the area of the upper third Pons region and vagal areas. The type of breathing pattern he will exhibit is:

   A. Apnea

   B. Ondine's

   C. Respiratory muscle paralysis

   D. Apneustic

7. A patient comes to the hospital after running head first into the corner of a brick wall in the cerebral region. He is apneic. Will his apnea most likely be temporary or permanent?

8. Describe the type of breathing seen with damage to the mesencephalon.

9. Which lesion would be less fatal in terms of breathing patterns produced - a lesion in the medulla or one in the cerebral hemispheres? Why?

10. A patient in ICU has heart failure. His pulse has slowed and stroke volume is decreased. A respiratory pattern that he may very likely develop could be what?

11. A boy, 4 years old, develops meningitis and is brought to Pediatrics. That night he is seen to be gasping. Short periods of apnea come in between a series of gasps. This pattern is called _____.

12. An application of this unit is seen in the somewhat frequent occurance of Cheyne-Stokes and Biot's in the hospital.
Do you feel confident that you could discuss the location in the brain and the etiologies (causes) of Cheyne-Stokes and Biot's with members of the medical team?

13. I liked this package because _____

_____

14. Students would like this package better if _____

_____

Feedback

1. Medulla, Pons, Spinal Cord, Mesencephalon & Diencephalon, Cerebral Cortex.

2. Inspiratory and Expiratory Centers

3. Pons

4. A. Cerebral Cortex is the highest center of the brain that helps control the fine rhythmicity of respiration. Stimulation of certain cerebral areas increase respiratory frequency and others inhibit respiration.

   B. Mesencephalon (midbrain) and Diencephalon (hypothalamus and thalamus), when stimulated by afferent impulses of heat, arousal, etc., increase tidal volume and/or respiration frequency.

   C. Pons again is a center higher than the medulla that offers maintainance of rhythm of both the inspiratory and expiratory phase.

   D. Pneumotaxic along with the Vagus nerve periodically inhibit the apneustic center so that expiration can take place. It also sends impulses to the medullary expiration center.

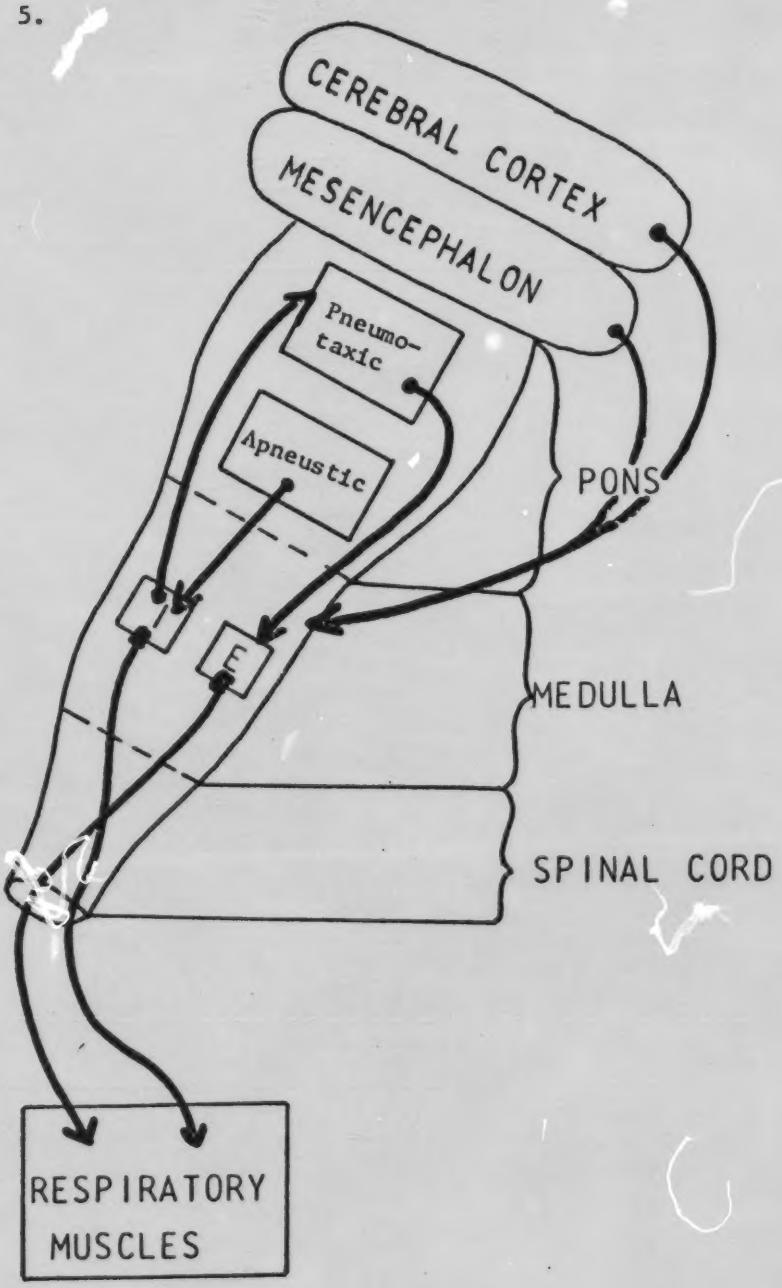
   E. Apneustic constantly sends impulses to the inspiratory center of the medulla - thus initiating inspiration.

   F. The medulla initiates and maintains the inspiration, expiration sequence, though if uncontrolled cannot maintain a normal rhythm. The inspiratory center has neurons that send impulses to the respiratory muscles during inspiration and conversely, the expiratory center during expiration.

   G. Spinal cord is the pathway for impulses between the brain centers and the respiratory muscles. It may also serve to help coordinate respiratory muscles when added work as singing, yodeling.

Feedback (continued)

5.



6. D

7. Temporary

8. Cheyne-Stokes

Feedback (continued)

9. Cerebral hemispheres, because the apnea produced is temporary. A medullary lesion causes permanent apnea.
10. Cheyne-Stokes, because if adequate blood flow per unit time does not reach the brain, the respiratory centers respond with this pattern.
11. Biot's

Well, you should feel very good, and ready to proceed to the next package!!!

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TROUBLESHOOTING AN MA-1 VOLUME VENTILATOR, IN REGARDS TO VOLUME LOSS

By

Jan L. Yestingsmeier, ARRT

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TITLE OF PACKAGE:	Troubleshooting an MA-1 Volume Ventilator in Regards to Volume Loss
AUTHOR:	Jan L. Yestingsmeier, AART
INSTITUTION:	El Centro Junior College, Dallas, Tex.
INTENDED STUDENTS:	Respiratory therapy
ESTIMATED WORKING TIME:	25 minutes
MATERIALS NEEDED:	An MA-1 is advisable, but not mandatory
REVISED:	Nov. 15, 1977

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INTRODUCTION

Loss of volume to a patient on a pre-set volume ventilator is a life-threathening situation. As time spent on finding and correcting the volume loss increases, the probability of permanent damage to the patient increases.

This learning package is designed to enable you to effectively troubleshoot the MA-1 volume ventilator, in regards to volume loss. You will be provided check lists, therefore shortening the time spent in determining the cause of volume loss.

Prior knowledge of the MA-1 and its components is recommended.

OBJECTIVES

In this package the overall objective is:

to effectively troubleshoot an MA-1 volume ventilator, in regards to volume loss

Sub-objectives:

You will be able to prepare a check list to aid in determining volume loss,

You will be able to determine volume loss when:
1) the normal pressure is exceeded,
2) the normal pressure is not met,
3) the normal pressure is met.

PRACTICE EXERCISE #1

The MA-1 is a volume pre-set ventilator, which delivers a fixed volume unless a chosen pressure limit is earlier reached. The pressure limit is generally set 10 Cm. H_2O above the pressure required to deliver that pre-set volume to the patient. If the pressure limit is reached, the patient won't receive his full tidal volume. This is caused by an obstruction, therefore causing an increase in pressure in an attempt to deliver the pre-set volume. An obstruction is anything which prohibits or blocks the passage of air to the patient. Examples of obstructions are:

1) increased secretion mobilization
2) the patient lying on the tubing system
3) the patient fighting the ventilator
4) water collecting in the tubing system
5) decreased lung compliance
6) the endotracheal or tracheal tube cuff herniating over the end of the tracheal tube.

Increased secretion mobilization is the most common cause of obstruction.

Question 1

All of the following are examples of volume loss when normal pressure is exceeded, except:

a) INCREASED SECRETION MOBILIZATION
b) PATIENT FIGHTING THE VENTILATOR
c) PATIENT LYING ON THE TUBING SYSTEM
d) A LEAK IN THE TUBING SYSTEM

Answer

The correct answer is d) A LEAK IN THE TUBING SYSTEM.

Increased secretion mobilization, patient fighting the ventilator, and patient lying on the tubing system are all examples of obstructions, which increase the pressure required to deliver the preset volume.

PRACTICE EXERCISE #2

If the normal pressure is not being met, and the preset volume is not being delivered, a leak on the patient side of the ventilator is present. A leak is any escape of the tidal volume to atmosphere before coming into contact with the patient. Examples of leaks are:

1) A LOOSE CASCADE
2) LOOSE TUBING CONNECTIONS
3) DISCONNECTED EXHALATION VALVE TUBING
4) A RUPTURED TRACHEAL TUBE CUFF
5) TOTAL PATIENT DISCONNECT
6) A RUPTURED EXHALATION DIAPHRAGM

A loose cascade is the most common cause of a leak.

Question #2

All of the following are examples of volume loss when normal pressure is not being met except:

a) TOTAL PATIENT DISCONNECT
b) A LOOSE CASCADE
c) INCREASED SECRETION MOBILIZATION
d) A RUPTURED TRACHEAL TUBE CUFF

Answer

The correct answer is c) INCREASED SECRETION MOBILIZATION. This causes an obstruction, therefore increasing the normal pressure. Total patient disconnect, a loose cascade, and a ruptured tracheal tube cuff are all examples of leaks, which cause a decrease in normal pressure.

PRACTICE EXERCISE #3

If a volume loss is present but the normal pressure is met, and not exceeded, there exists either a leak of the exhalation side of the ventilator, or the patient is not exhaling his full tidal volume. Examples of this are:

1) A MALFUNCTIONING MONITORING SPIROMETER
2) A LOOSE CONDENSER VIAL (2500 VIAL)
3) AIR LEAKING THROUGH CHEST TUBES
4) AIR TRAPPING

If ALL connections are tight, and the monitoring spirometer appears to be working properly, obtain a Wright respirometer and place it in-line on both the ventilator side and exhalation side of the system. If the volume exhaled from the patient is less than the volume delivered to the patient, the patient is either air trapping or leaking air through chest tubes.

Question #3

All of the following are examples of volume loss, but normal pressure except;

1) CHEST TUBE DRAINAGE
2) MALFUNCTIONING MONITORING SPIROMETER
3) AIR TRAPPING
4) DISCONNECTED EXHALATION VALVE TUBING

Answer

The correct answer is d) DISCONNECTED EXHALATION VALVE TUBING. This creates a leak, causing a decrease in the normal pressure.

Chest tube drainage, air trapping, and malfunctioning monitoring spirometer will not create a change in the normal pressure.

PRACTICE EXERCISE # 4

When volume loss is suspected, first check your patient to assure he is being adequately ventilated. Then check the pressure manometer to determine the cause of the volume loss. If the normal pressure is exceeded, an obstruction is present. If the normal pressure is not being met, a leak on the patient side of the ventilator is present. If the normal pressure is met, but the patient is still not receiving his preset volume, there is either a leak on the exhalation side of the ventilator, or the patient is not exhaling fully.

Question #4

If a loss in preset volume is present, how would you determine if the pressure is being met?

a) CHECK THE PATIENT
b) CHECK THE PRESSURE MANOMETER
c) CHECK THE CASCADE
d) CHECK THE MONITORING SPIROMETER

Answer

The correct answer is b) CHECK THE PRESSURE MANOMETER.

Checking the patient would tell you whether or not he were being ventilated. Checking the cascade or spirometer could only predict a possible leak, but provided only the above information, you don't know the cause of the volume loss.

POST-TEST

1. The preset volume is not met, and the normal pressure is exceeded. One would expect:

   a) A LEAK
   b) AN OBSTRUCTION
   c) A MALFUNCTIONING MONITORING SPIROMETER
   d) AIR TRAPPING

2. The preset volume is not met, and the normal pressure is not met. One would suspect:

   a) A LEAK ON THE PATIENT SIDE OF THE VENTILATOR
   b) AN OBSTRUCTION
   c) A MALFUNCTIONING MONITORING SPIROMETER
   d) THE PATIENT IS FIGHTING THE RESPIRATOR

3. A volume loss is present, but the normal pressure is met. One would suspect:

   a) A LEAK ON THE PATIENT SIDE OF THE VENTILATOR
   b) AN OBSTRUCTION
   c) A MALFUNCTIONING MONITORING SPIROMETER
   d) THE PATIENT IS LYING ON THE TUBING SYSTEM

4. The most common cause of leaks on the patient side of the ventilator occurs:

   a) AT THE PATIENT
   b) AT THE CASCADE
   c) AT THE EXHALATION VALVE TUBING
   d) AT THE MONITORING SPIROMETER

5. The most common cause of obstruction is:

   a) INCREASED SECRETION MOBILIZATION
   b) PATIENT LYING ON THE TUBING SYSTEM
   c) AIR TRAPPING
   d) PATIENT FIGHTING THE RESPIRATOR

6 If a loss in preset volume is present, how would you determine if the pressure is being met?

   a) CHECK THE PATIENT
   b) CHECK THE PRESSURE MANOMETER
   c) CHECK THE CASCADE
   d) CHECK THE MONITORING SPIROMETER

POST-TEST ANSWERS

1. b) AN OBSTRUCTION

2. a) A LEAK ON THE PATIENT SIDE OF THE VENTILATOR

3. c) A MALFUNCTIONING MONITORING SPIROMETER

4. b) AT THE CASCADE

5. a) INCREASED SECRETION MOBILIZATION

6. b) CHECK THE MONITORING SPIROMETER

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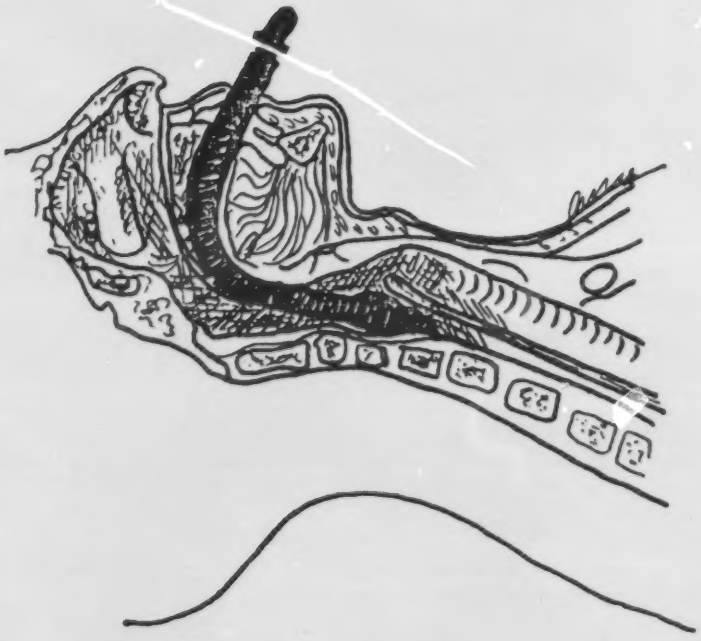
HOW TO PERFORM ORAL ENDOTRACHEAL INTUBATION ON AN ADULT MANIKIN

By

Linda Slater



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TITLE OF PACKAGE:	How to Perform Oral Endotracheal Intubation on an Adult Manikin
AUTHOR:	Linda S. Slater, R.R.T.
INSTITUTION:	Orange Coast College
INTENDED STUDENTS:	Respiratory Therapy, Emergency Medical Technician, Paramedic, Nursing
ESTIMATED WORKING TIME:	30-60 minutes
MATERIALS NEEDED:	Laerdal Intubation Manikin laryngoscope with straight and curved blades various sized adult endotracheal tubes stylet lubricant airway (size 3 and 4) resuscitator bag (adult) 10-20 cc syringe stethoscope adhesive tape suction set-up stop watch or watch with second hand
FIELD TEST COPY:	

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INTRODUCTION

"CODE BLUE --304, CODE BLUE -- 304," cried the telephone operator. It's 1:00 a.m. and you are the only respiratory therapist in the hospital now. You run to room 304, get a resuscitator bag off the crash cart and begin pulmonary resuscitation. Minutes pass and the patient shows no sign of improvement. You can't seem to ventilate as effectively as you would like. The patient needs to have an endotracheal tube inserted.

This is not an unusual situation in which a respiratory therapist or similar allied health professional would find himself. If you were trained and experienced in endotracheal intubation, you could go ahead and intubate that patient without delay and possibly save that patient's life. Many hospitals have now recognized that respiratory therapists and others can and should be trained in endotracheal intubation. The purpose of this self-instructional package is to teach you to perform endotracheal intubation so that when you are in a situation similar to this one, you can act appropriately and without delay.

OVERALL OBJECTIVE

After completing this package, you will be able to successfully intubate an adult manikin orally without referring to this package or any other references.

SUB-OBJECTIVES

Without referring to the text of this package or other resources, you will:

1. Obtain the equipment (in proper working order) necessary for performing oral endotracheal incubation.

2. Position the manikin such that the mouth, pharynx and larynx are in a single plane.

3. Insert the laryngoscopy blade into the right side of the mouth while moving the tongue to the left side.

4. Advance the laryngoscope tip below the epiglottis (straight blade laryngoscope) or above the epiglottis (curved blade laryngoscope).

5. Clearly visualize the glottis by raising the laryngoscope upward and outward.

6. Insert the appropriately sized endotracheal tube through the glottis so that the upper border of the tube cuff is about one inch below the glottis.

7. Insure proper placement of the tube by checking for the presence of bilateral breath sounds.

8. Secure the endotracheal tube immediately after insertion.

9. Perform steps 3 through 7 in 15 seconds or less.

10. By anonymously critiquing this package, you will find that it is a good way to learn oral endotracheal intubation.

Practice Exercise #1: ASSEMBLING EQUIPMENT

Before attempting to intubate a patient, it is essential to obtain all of the supplies and equipment necessary to perform the procedure. Furthermore, you will need to be certain that this equipment is in proper working order. You could jeopardize a patient's life if you attempt to intubate him and find that you are not adequately prepared.

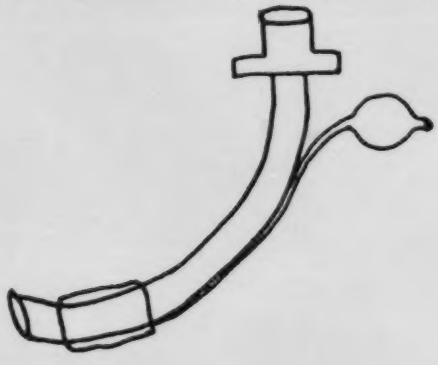


FIGURE 1: ENDOTRACHEAL TUBE

Figure 1 is an ENDOTRACHEAL TUBE. You will be inserting the largest sized endotracheal tube that will fit through the glottis without force. Since it is impossible to know the size of a patient's glottis without visualizing it via the laryngoscope, you must have several sizes on hand so that you can use the correct size. The adult female will usually accomodate a size 8 (8 mm I.D.) tube while the adult male will usually accommodate a size 9 (9mm I.D.) tube. It is wise to have a selection of tubes available ranging from size 7 or 7.5 to 9.5 or 10. The tube size is marked on the tube itself and on its package.

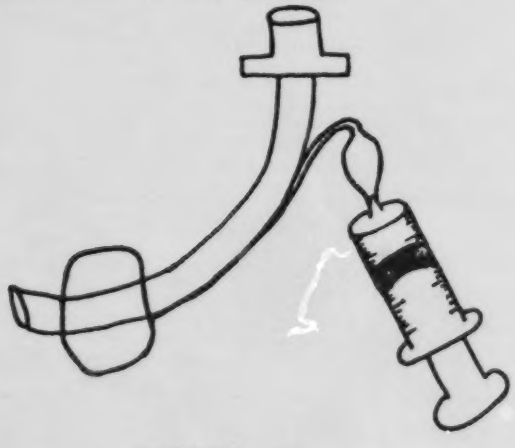
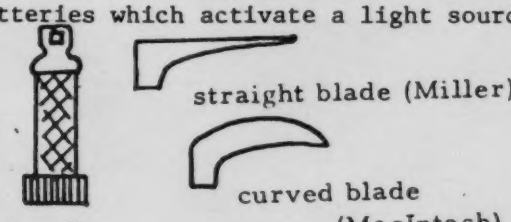


FIGURE 2

Note that near the beveled tip of the endotracheal tube is a cuff. All adult endotracheal tubes have cuffs. Occasionally these cuffs will be defective, that is, they will not inflate evenly or they will not hold air. It is very important to check for a defective cuff. To check for a defective cuff, simply fill it with approximately 10 cc of air with a syringe (see figure 2). Make sure that it inflates evenly and that it holds air. (Do not contaminate the cuff by touching it, only observe that it holds air). Discard any tube found to have a defective cuff.

Pick out the endotracheal tubes from the array of supplies and equipment in front of you. Arrange the tubes in some order so that you can easily pick out any size tube you need.

Figure 3 is a LARYNGOSCOPE. A laryngoscope is the instrument used to open up the airway so that the glottis (opening into the trachea) can be visualized. It consists of a handle and a blade. The handle contains two batteries which activate a light source on the blade. The blade may be one of two common shapes, straight (Miller) or curved (MacIntosh). Only one blade actually needs to be available for use during intubation. It is a matter of preference as to which blade to use, you will decide later which one you prefer. A small light bulb is located at the tip of the blade.



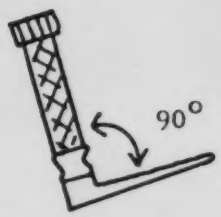


FIGURE 3: LARYNGOSCOPE

The laryngoscope handle and blade lock together so that when the blade is extended to a 90° angle with the handle, the light is activated. It is very important to check for activation of the light before attempting to intubate. If the light does not work, you will be unable to see what you are doing in the patient's airway after the laryngoscope is inserted. The light will not be activated when (1) the batteries are dead or they are placed into the handle improperly and, (2) the light bulb is burned out or loose within the socket. If your light does not work, check the batteries and light bulb and replace if necessary.

Pick up the laryngoscope handle and two blades from the array of supplies and equipment in front of you. Practice locking each blade onto the handle. You will know that you have done it correctly when the light comes on. Replace the batteries and/or light bulb if necessary.

* * * *

Figure 4 is a STYLET. A stylet is a bendable wire that, when inserted into the endotracheal tube, will enable the tube to hold any shape desired. A stylet is needed only when the patient's airway has an abnormal shape and the tube cannot be inserted without it. The stylet should be present in case you encounter a patient with this abnormality.

FIGURE 4: STYLET

Pick out the stylet from the array of supplies and equipment in front of you. Note how easily it bends by putting it into several different shapes. Place it inside of an endotracheal tube and bend it into different shapes.

* * * *

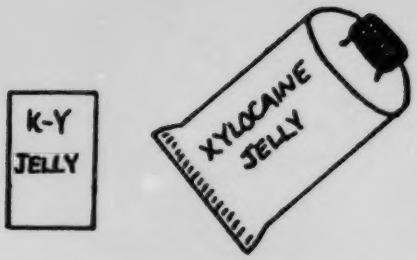


FIGURE 5: LUBRICANTS

Figure 5 represents two types of LUBRICANTS used to lubricate the endotracheal tube. Sterile, water-soluble jelly (a) or jelly containing a topical anesthetic agent (b) are commonly used for this purpose.

Pick out the lubricant found in the array of supplies and equipment in front of you.

* * * *

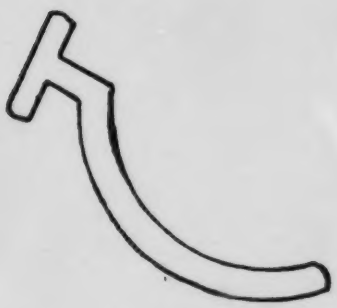


FIGURE 6: AIRWAY

Figure 6 is an OROPHARYNGEAL AIRWAY or just AIRWAY. An airway is placed in the patient's mouth and oropharynx after inserting the endotracheal tube to prevent the patient from biting down on the tube and also, to provide a route to suction secretions from the mouth.

The airway should be the appropriate size. For an adult with a small or medium facial structure, a size 3 will fit. For an adult with a large facial structure, a size 4 will fit.

Pick out the airway from the supplies and equipment in front of you. Look at the manikin and decide what size you will need.

* * * *

FIGURE 7: RESUSCITATOR BAG

Figure 7 is a RESUSCITATOR BAG. A resuscitator bag is used to administer deep breaths to the patient after tube insertion. Or, if the patient is not breathing, it is needed to manually ventilate him prior to and directly after inserting the tube. Pick out the resuscitator bag from the supplies and equipment in front of you.

FIGURE 8: SYRINGE

FIGURE 9: STETHOSCOPE

FIGURE 10: TAPE

Figure 8 is a SYRINGE. A syringe, without the needle, is needed to inflate the cuff of the tube after it is inserted. A 10-20 cc syringe is usually the best size. Pick out the syringe from the supplies and equipment in front of you.

* * * *

Figure 9 is a STETHOSCOPE. A stethoscope should be available so that after inserting the tube, you can auscultate the chest and determine if both lungs are being ventilated properly. Chances are, if both sides of the chest are not being ventilated properly, the tube is not placed correctly in the trachea. Pick out the stethoscope from the supplies and equipment in front of you.

* * * *

Figure 10 represents a roll of ADHESIVE TAPE. Adhesive tape is used to secure the tube after insertion so that it will not come out. Pick out the adhesive tape from the supplies and equipment in front of you.

(NOTE: Occasionally a tube harness is used. A tube harness is a device that holds the tube in place without using tape. Built into the tube harness is a bite block which will also prevent the patient from biting down on the tube. If a tube harness is used, an airway and adhesive tape are unnecessary.)

* * * *

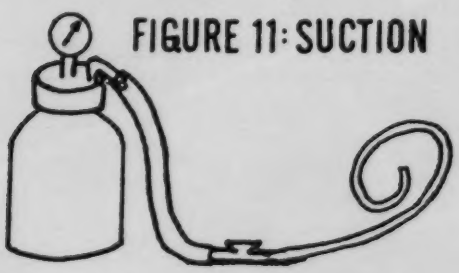


FIGURE 11: SUCTION

Figure 11 is a SUCTION SET-UP. Suction may be necessary to evacuate secretions from the pharynx and trachea during intubation. The suction should be turned on and the suction catheter attached so that it can be used quickly when necessary. Set up the suction apparatus provided, turn it on, attach the suction catheter and check to be sure it is ready to use.

TO SUMMARIZE:

Figure 12 shows the assembly of equipment you should obtain prior to attempting to intubate a patient. Study this diagram before continuing on the Practice Question #1.

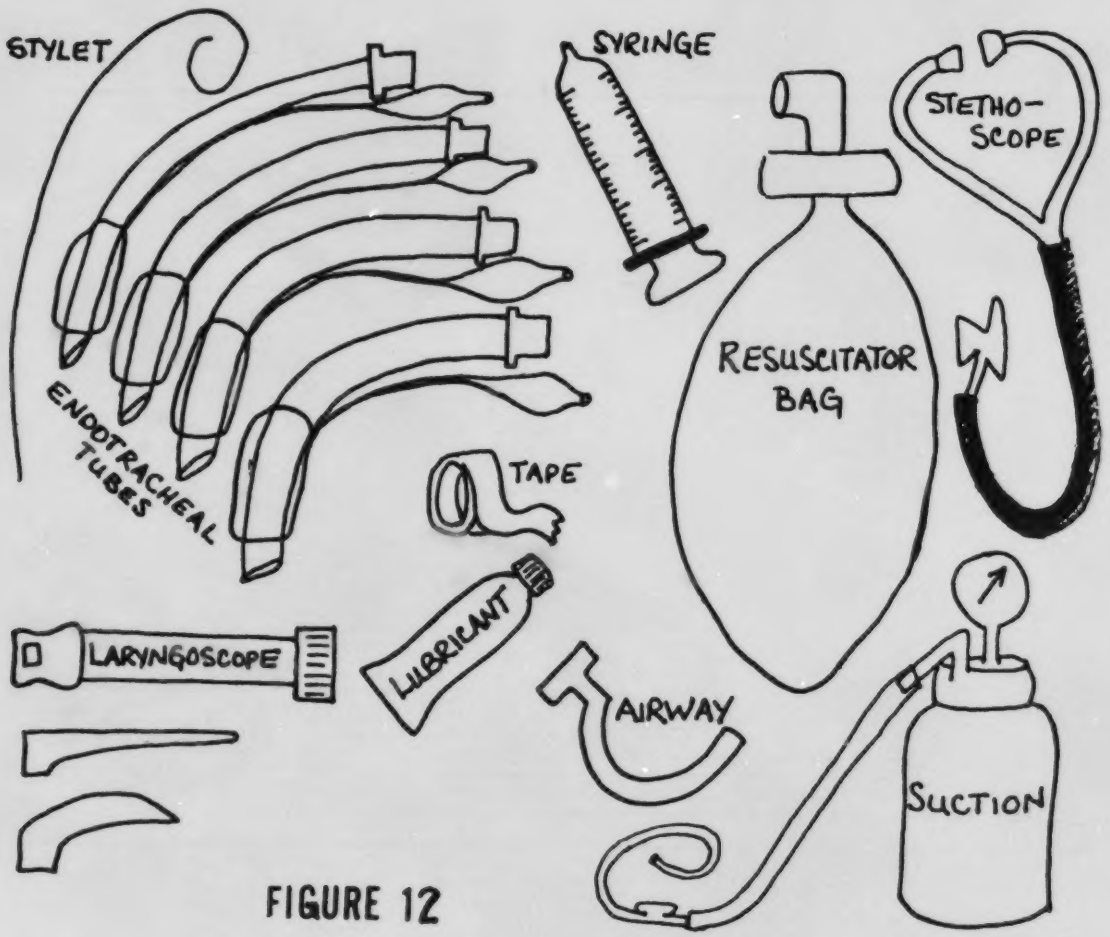


FIGURE 12

Practice Question #1:

Mix up the supplies and equipment provided you. Then, assemble all the supplies and equipment you need to perform endotracheal intubation near the manikin. Check to make sure that everything is in proper working order.

Feedback:

Did you assemble the following?

1. endotracheal tubes of various sizes from 7 or 7.5 to 9.5 or 10 with non-defective cuffs
2. laryngoscope with two blades and a handle and a functional light source
3. stylet
4. lubricant
5. airway
6. resuscitator bag
7. 10-20 cc syringe
8. stethoscope
9. adhesive tape
10. suction set-up with the suction on and the suction catheter attached

If you assembled all of the above supplies and equipment, good job! Continue on to the next page. If you missed something, please review practice exercise #1 again.

Practice Exercise #2: POSITIONING THE HEAD

The next step in performing endotracheal intubation is to position the patient in order to facilitate entry of the tube into the trachea. In the resting position in figure 13, the upper airway makes two bends. It is difficult, to say the least, to pass a plastic tube around these bends. Therefore, it would be advantageous to position the patient's head and neck in such a way that the upper airway is a straight path.

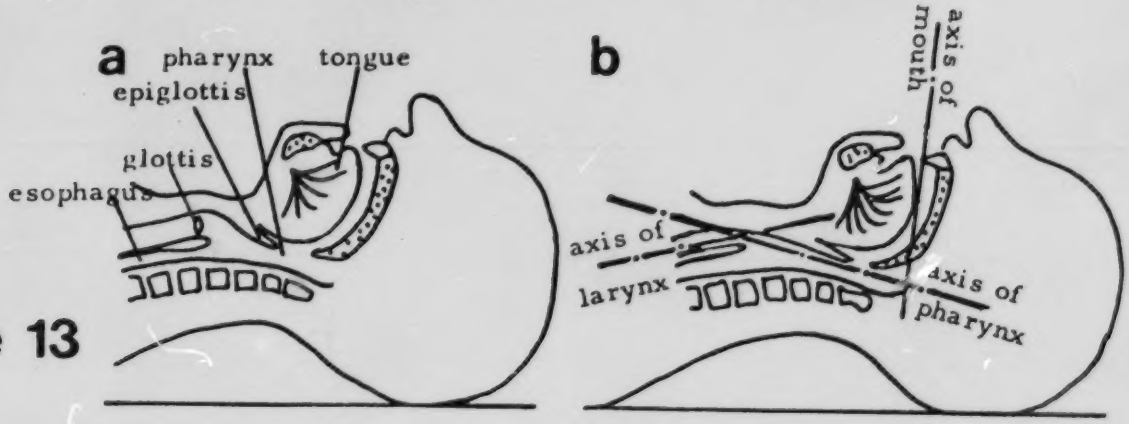


figure 13

The pharynx and larynx can be made to come into a straight line by raising the patient's head onto a folded towel or small pillow (figure 14). The mouth can then be made to come into a straight line by hyperextending the neck (figure 15).

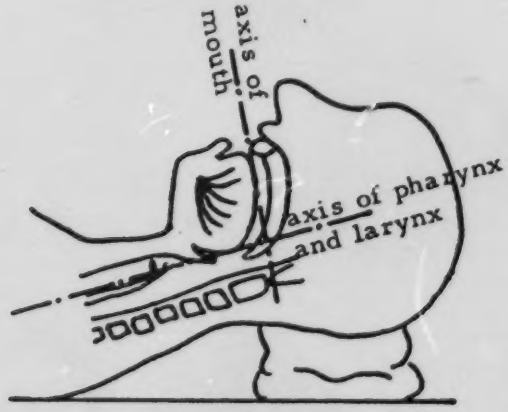


figure 14

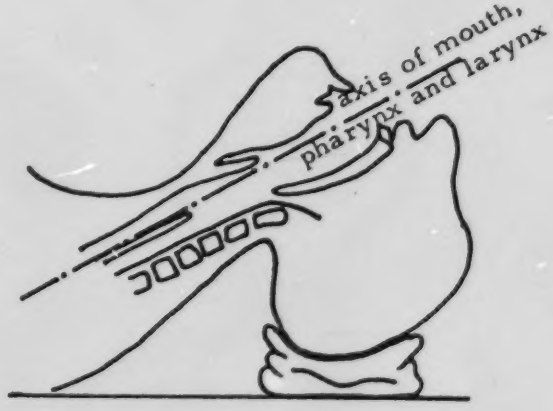


figure 15

Practice Question #2:

Position the manikin's head properly for endotracheal intubation.

Feedback:

If you raised the manikin's head onto a folded towel or small pillow and then hyperextended the neck, YOU ARE CORRECT!

If you did not position the manikin like this, do it again before continuing on to the next practice exercise. Remember, we want to make the upper airway a straight path so we raise the head onto a folded towel or small pillow to make the pharynx and larynx come into a straight line then, hyperextend the neck to make the mouth come into a straight line with the pharynx and larynx.

Practice Exercise #3: INSERTING THE LARYNGOSCOPE

Once you have assembled the necessary equipment and positioned the manikin, you are ready for the actual insertion of the tube. Oral endotracheal intubation is performed by directly visualizing the glottis with the aid of a laryngoscope. The first step is to visualize the pharynx so that you can orient yourself to the anatomical structures seen.

First, hold the laryngoscope handle with the straight blade locked in place in your left hand whether you are right-handed or left-handed. Insert the laryngoscope blade half-way into the mouth by entering the right side of the mouth and pointing the tip medially (toward the center of the pharynx). Be careful to avoid accidental laceration of soft tissues in contact with the blade and chipping of teeth.

figure 17

By entering the mouth on the right side and pointing the tip of the blade medially, you are able to push the tongue to the left side of the mouth and out of the way so that it will not obstruct your line of sight (see Figure 17).

Practice Question #3:

Insert the laryngoscope into the manikin's mouth properly.

Feedback

With the laryngoscope in your left hand, did you insert the laryngoscope blade into the right side of the mouth and point the blade tip medially so that the tongue is pushed to the left side of the mouth? Good! Now lift upward and outward (away from you). You should see a pink flap obstructing the glottis, that is, the epiglottis.

If you did not do this, keep practicing until you are able to do so before continuing on to the next practice exercise.

Practice Exercise #4: ADVANCING THE LARYNGOSCOPE

Now you must decide which laryngoscope blade you prefer. A brief review of upper airway anatomy is needed.

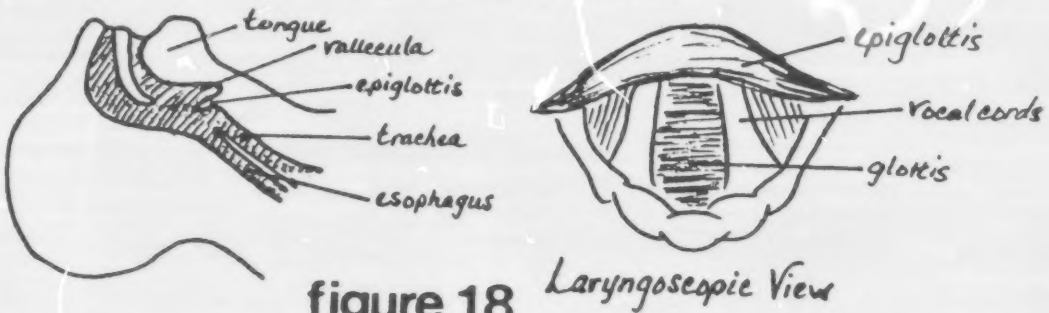


figure 18

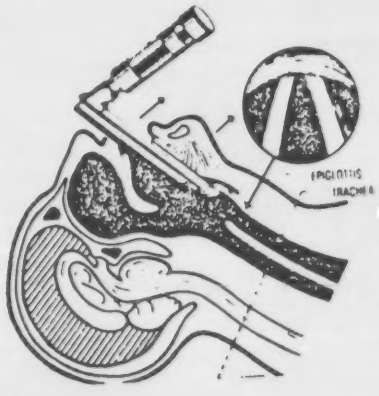
The epiglottis is a large, single cartilage of the larynx. Its purpose is to close the glottis during swallowing so that fluid and solid food will not go down the trachea but rather go down the esophagus. The epiglottis attaches at the upper part of the larynx on the inner surface anteriorly. In a laryngoscopic view (looking through a laryngoscope), it attaches superiorly (on top) and hangs downward. There is a small groove formed between the base of the tongue and the epiglottis, this groove is the vallecula or supraepiglottic groove. The esophagus lies posterior (behind) the trachea. In a laryngoscopic view, the esophagus is below the glottis and since it is not held open by cartilage rings as is the trachea, it appears as a flattened tubular opening (see figure 18).

The purpose of the laryngoscope is to open up the airway so that the glottis can be visualized and subsequently a tube inserted through it. The straight and curved blades of the laryngoscope allow you to do this but in slightly different ways. First, let us consider the straight blade since it is the one most often preferred.

Straight Blade

The straight blade is used to directly elevate the epiglottis so that the glottis can be seen. After locating the epiglottis, the straight blade is advanced BELOW the epiglottis. Lifting of the laryngoscope upward and outward will cause a direct lifting of the epiglottis and the glottis will be seen (see figure 19).

figure 19



Curved Blade

The use of the curved blade differs from the straight blade in that the epiglottis is indirectly elevated. After locating the epiglottis, the tip of the curved blade is advanced ABOVE the epiglottis into the vallecula or supraepiglottic groove. Lifting of the laryngoscope upward and outward will lift the upper portion of the larynx and therefore, the epiglottis as well since it is attached at this area (see figure 20).

figure 20

Practice using both the straight and curved blades on the laryngoscope a few times before doing practice question #4. Decide which blade you prefer.

Practice Question #4:

Advance either the straight or curved blade laryngoscope (whichever you prefer) so that the glottis can be visualized.

Feedback:

If you used the straight blade laryngoscope, did you advance the tip BELOW the epiglottis? If you used the curved blade laryngoscope, did you advance the tip ABOVE the epiglottis?

If you now lift the laryngoscope upward and outward, you will know that you have placed the blade correctly because you will see the glottis, a black, triangular opening surrounded by two pearly white strands (the vocal cords).

Practice Exercise #5: VISUALIZING THE GLOTTIS

The laryngoscope is now in place for visualizing the glottis. The correct way of exposing the glottis with the laryngoscope is to lift the handle upward and outward (away from you). The tendency is to pull back on the laryngoscope handle -- this is INCORRECT. Pulling backward on the laryngoscope handle will cause undue pressure on the upper teeth (as shown when the light beside the manikin's shoulder comes on) and possible chipping or breaking of the teeth. Pulling backward on the laryngoscope handle may also cause tearing of the pharynx or epiglottis because of the pressure applied by the blade tip. Remember, you want to lift up the epiglottis. Therefore, lift the laryngoscope upward and outward (see figure 21).

figure 21

Practice Question #5:

With the laryngoscope in place, correctly visualize the glottis.

Feedback:

Did you lift the epiglottis by pushing the laryngoscope handle upward and outward? You should now see the glottis as a black, triangular opening surrounded by two pearly white strands (the vocal cords).

If the light next to the manikin's shoulder comes on because you are applying pressure on the upper teeth, try again. Remember, lift the laryngoscope upward and outward.

Practice Exercise #6: INSERTION OF THE TUBE

Now that you can see the glottis, it is time to insert the endotracheal tube.

(NOTE: When intubating a real patient, it is necessary to lubricate the tube with the lubricant you had previously prepared before attempting to insert it. With the manikin, however, lubricant is unnecessary.)

At the time you see the glottis, you must first decide the size of tube that will easily fit through without requiring force. The average adult female trachea will usually accomodate a size 8 (8 mm I.D.) tube while the adult male trachea will usually accomodate a size 9 (9 mm I.D.) tube. Take the size tube you need from the tubes previously prepared with your right hand. Insert the tube into the right side of the mouth, do not obscure your view by inserting the tube through the groove in the laryngoscope blade.

Push the tube through the glottis until the upper border of the tube cuff is about one inch below the glottis. Watch carefully as you insert the tube. Do not assume that the tube will go into the trachea. The esophagus lies just below the trachea. If you do not see the tube go into the trachea, then it has gone into the esophagus. Pull the tube out of the esophagus and re-insert it into the trachea. The tip of the tube must lie well below the glottis in order to be able to seal off the trachea for artificial ventilation yet be above the carina so that air can pass into both mainstem bronchi. A good rule of thumb is to insert the tube so that the upper border of the cuff is about one inch below the glottis. The tube position can be readjusted later if necessary.

Insertion of the tube may be complicated by laryngospasm. If you see that the vocal cords are closed, do not attempt to push the tube through them because you may cause permanent damage. Since the patient cannot ventilate with closed vocal cords, they will eventually open when he becomes sufficiently hypoxic or he inspires. Simply wait until the cords finally open, then insert the tube.

Practice Question #6:

With the glottis visualized, insert the correct sized endotracheal tube to the correct depth in the trachea.

Feedback:

Did you insert a tube that is the largest size that will fit the glottis without force (about a 9 or 9.5 mm on the manikin) into the mouth to the right of the laryngoscope blade? Did you push it to a depth where the upper border of the tube cuff is about one inch below the glottis? If you were able to do this step, continue on to practice exercise #7. If not, try again before continuing on.

Practice Exercise #7: CHECKING TUBE PLACEMENT

After the tube is properly inserted into the trachea, quickly remove the laryngoscope while at the same time holding the tube securely in place. Next, inflate the cuff, attach your resuscitator bag and administer a few manual breaths. Use your stethoscope to listen for breath sounds over the anterior chest on both sides.

It is important to immediately insure that the tube is properly placed. If the tube is improperly placed, the patient will not be able to ventilate sufficiently. There are two main areas of misplacement.

(1) ESOPHAGUS

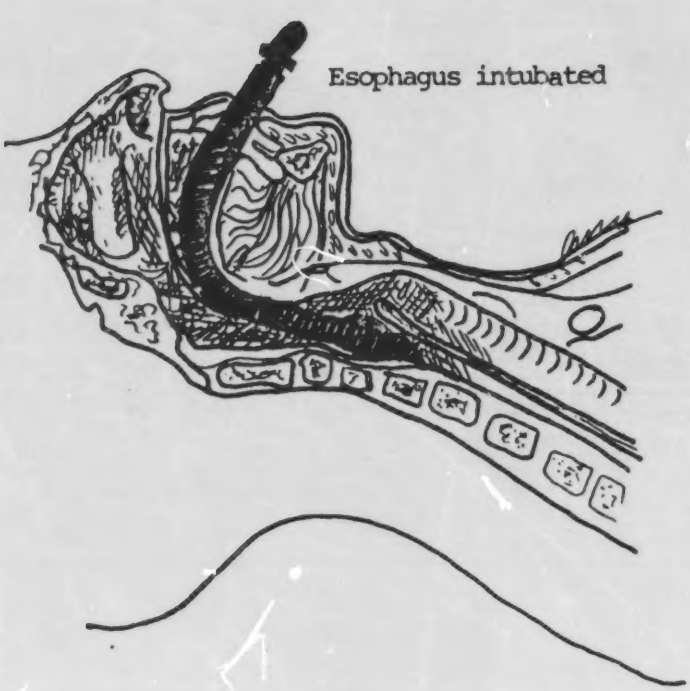
Poor visualization of the glottis and failure to see the tube pass into the trachea will lead to intubation of the esophagus. If this should occur, no breath sounds will be heard during administration of manual breaths with the resuscitator bag. Instead, you may hear gurgling sounds and air entering the stomach. The stomach will also rise as it is filled with air. If you find that you have intubated the esophagus, immediately deflate the cuff and remove the tube. Re-attempt it after the patient has been allowed to oxygenate for a while.

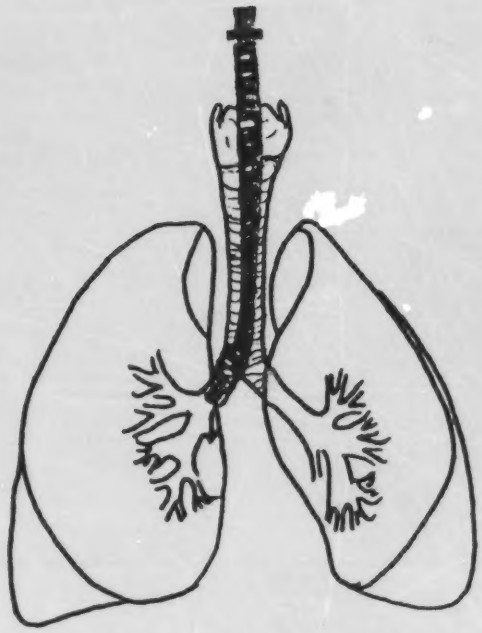
(2) RIGHT MAINSTEM BRONCHUS

If the tube is pushed too far into the trachea, it will go into the right mainstem bronchus. Since the right mainstem bronchus lies at a nearly straight path from the trachea while the left makes a more acute angle, the tube will tend to follow to the right. If this should occur, breath sounds will be absent over the left chest and present over the right chest. If you find that the tube has gone into the right mainstem bronchus, deflate the cuff and pull it out about an inch. Re-inflate the cuff and listen for breath sounds on both sides of the chest again.

Once you are reasonably sure that the tube is placed correctly and patient ventilation established, a chest X-ray should be taken to double check tube placement. Since most endotracheal tubes have a strip through it that will show up on X-ray, the tip of the tube can be easily spotted and determined whether it lies correctly in the trachea, above the carina (see figure 22).

figure 22





Endotracheal tube in right bronchus

Practice Question #7:

With the tube inserted, make sure that it is properly placed in the manikin as though it is an actual patient.

Feedback:

Did you auscultate both sides of the chest anteriorly? Did you hear breath sounds on both sides? Double check yourself by observing lung inflation under the covering of the chest on the manikin.

If the tube is improperly placed, correct the problem and re-check by auscultating again. Do not continue to the next practice exercise until you are sure that the tube is properly placed in the trachea, above the carina.

Practice Exercise #8: SECURING THE TUBE

The endotracheal tube should now be properly placed in the manikin and ready for securing. Hold onto the tube until it is properly secured. You do not want to jeopardize your efforts thus far by letting go of the tube and having it slip down or out. At this time an airway is usually inserted into the mouth. An airway prevents the patient from biting down and occluding the tube and it also provides a route to insert a suction catheter for removing oral secretions.

Endotracheal tubes are usually secured by applying adhesive tape. Adhesive tape is used because it is stronger and sticks better than paper or plastic tape. Each hospital usually has a special method of taping the tube. Whatever the method, however, it has to be done securely. A method that I have found to be quite successful is the "ear-to-ear" method. Start the tape at one earlobe, tape across the face to the mouth, around the tube then around the tube and airway, and across the other side of the face to the opposite earlobe. It may seem cruel to the patient but, a good taping job can prevent problems later if the tube were to come out. After taping the tube, check to be sure that it is secure by lightly tugging on it.

Practice Question #8:

With the tube properly placed in the manikin, tape it securely.

Feedb

Did you use adhesive tape starting at one earlobe, across the face, around the tube, around the tube and airway, and across the other side of the face and to the opposite earlobe? Lightly tug on the tube. Will it come out easily?

Congratulations! You have now successfully performed oral endotracheal intubation on the manikin. Continue on to the final, overall practice exercise.

OVERALL PRACTICE EXERCISE

You will frequently be called upon to perform oral endotracheal intubation on a patient in cardiopulmonary arrest. The American Heart Association recommends that cardiac compression be stopped for no longer than 15 seconds for intubation. Therefore, it is necessary to perform the insertion of the laryngoscope, visualizing of the glottis and insertion of the tube within the allotted 15 seconds.

Now that you have successfully completed each step, practice the entire procedure until you can do it without referring to the package or other resources and within 15 seconds. After you feel that you have practiced enough, ask a partner to check you off on the following check sheet. When you are confident that you can perform each step correctly, proceed to the Post-test.

INTUBATION CHECKSHEET

DID YOUR PARTNER:	YES	NO
1. obtain and check that the following equipment is in proper working order: a. endotracheal tubes of various sizes and non-defective cuffs		
b. laryngoscope with working light source		
c. stylet		
d. lubricant		
e. airway		
f. resuscitator bag		
g. 10-20 cc syringe		
h. stethoscope		
i. adhesive tape		
j. suction set-up with the suction on and catheter attached		
2. position the manikin's head on a fold towel or small pillow and hyperextend the neck?		
3. holding the laryngoscope in the left hand, insert the blade into the right side of the mouth, point the blade medially and push the tongue to the left side of the mouth?		
4. advance the laryngoscope tip below the epiglottis (straight blade) or above the epiglottis (curved blade)?		
5. visualize the glottis by raising the laryngoscope upward and outward?		
6. insert as large an endotracheal tube that will fit through the glottis without force to a level where the cuff is about one inch below the glottis?		

Continued on next page.

INTUBATION CHECKSHEET (continued)

DID PARTNER:	YES	NO
7. insure proper placement of the tube by auscultating and hearing bilateral breath sounds? check your partner by observing lung inflation)		
8. perform steps 3 through 6 in 15 seconds or less?		
9. secure the tube with adhesive tape and check to make sure that it cannot pull out easily?		

Proceed to the post-test.

POST-TEST

You are to perform oral endotracheal intubation of the adult manikin. You must complete the actual insertion of the tube within 15 seconds and without referring to this package or other resources. The checksheet below should be given to your partner so that he/she can check you off for each step as you perform the intubation. If you receive a "NO" on any item, repeat the entire procedure until you receive a "YES" on all items.

INTUBATION CHECKSHEET

DID YOUR PARTNER:	YES	NO
1. obtain and check that the following equipment is in proper working order: a. endotracheal tubes of various sizes and non-defective cuffs		
b. laryngoscope with working light source		
c. stylet		
d. lubricant		
e. airway		
f. resuscitator bag		
g. 10-20 cc syringe		
h. stethoscope		
i. adhesive tape		
j. suction set-up with the suction on and catheter attached		
2. position the manikin's head on a folded towel or small pillow and hyperextend the neck?		
3. holding the laryngoscope in the left hand, insert the blade into the right side of the mouth, point the blade medially and push the tongue to the left side of the mouth?		
4. advance the laryngoscope tip below the epiglottis(straight blade) or above the epiglottis(curved blade)?		
5. visualize the glottis by raising the laryngoscope upward and outward?		
6. insert as large an endotracheal tube that will fit through the glottis without force to a level where the cuff is about one inch below the glottis?		
7. insure proper placement of the tube by auscultating and hearing bilateral breath sounds? (check your partner by observing lung inflation)		
8. perform steps 3 through 6 in 15 seconds or less?		
9. secure the tube with adhesive tape and check to make sure that it cannot pull out easily?		

You have now completed this self-instructional package. Congratulations! you have done an excellent job.

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A PROJECT OF THE LEAGUE FOR INNOVATION IN THE COMMUNITY COLLEGE

BACTERIAL SURVEILLANCE

By

Linda Slater, ARRT

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TITLE:	Bacterial Surveillance
AUTHOR:	Linda Slater, ARRT
INSTITUTION:	Orange Coast College, Costa Mesa, Calif.
INTENDED STUDENTS:	Respiratory therapy
WORKING TIME:	30 minutes
MATERIALS NEEDED:	None

FIELD TEST COPY

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OBJECTIVES

Your goal is to understand the use and procedures for bacterial surveillance in respiratory therapy. You will:

Define bacterial surveillance.

Discuss the conditions advantageous for microbial growth.

Discuss the ways microbes are carried to patients.

Given a clinical situation, describe areas where microbes are probably growing.

Describe two methods of obtaining equipment cultures.

Describe an effective system for bacterial surveillance.

Bacterial surveillance is the act of watching for growth of microorganisms. Although the term is "bacterial" because the most common microbial contaminants are bacteria, we are concerned with all contaminating microorganisms. Since microorganisms cannot be seen with the naked eye, indirect methods for detecting them must be used.

Bacterial surveillance involves establishing a well-planned system for searching out and following-up on equipment contaminated with microorganisms. Knowledge of conditions favorable for microbial growth, how microbes are transported from one site to the next and methods for obtaining microbial cultures is essential for establishing this system.

Question 1.

Define bacterial surveillance

Check your answer at the top of the next page.

Answer

1. Bacterial surveillance is the act of watching for growth of microorganisms.

Question 2.

What does a "system" for bacterial surveillance entail?

Check your answer on the next page.

* * * *

CONDITIONS FAVORING MICROBIAL GROWTH

Microorganisms require a warm, moist environment in order to survive.

The optimal temperature range for microbes pathogenic to man is $\pm$ 10°C of body temperature.

Question 3.

Describe two respiratory therapy equipment items which provide environments for microbes in this temperature range.

Check your answer at the top of the next page.

Answers

2. A system for bacterial surveillance entails searching out and following-up on equipment contaminated with microorganisms.

3. Aerosol devices such as heated aerosols and ultrasonic nebulizers and IPPB machines and ventilators with heated nebulizers incorporated into their circuits operate in the optimal temperature range. Additionally, items such as spirometers that collect gas exhaled from patients or endotracheal and tracheostomy tubes placed within the patient's airway have temperatures in the optimal range.

Although we speak of $\pm$ 10°C of body temperature as the optimal range, microbes can still survive in lower and higher temperatures. Their growth is not as great, however, outside this optimal range.

The presence of water is absolutely essential for microbial growth. Microbes, like all other known forms of life, require water in order to survive. If water is not present, they will shrink and die.

Question 4.

With the conditions favoring microbial growth in mind, why is respiratory therapy equipment so often the source of patient contamination?

Check your answer at the top of the next page.

Answer

4. Respiratory therapy equipment is a frequent source of patient contamination because most of it is used with water or other solutions and quite often the temperatures of these solutions are in the optimal range.

Bacteria capable of forming spores will form spores when faced with unfavorable environmental conditions. Spores, as you will remember, are encapsulated in a tough outer coat which makes it very difficult to kill them. Equipment contaminated with spore-forming bacteria that is later dried or cooled or both may still be contaminated with the bacterial spores.

TRANSPORTATION OF MICROBES

MICROORGANISMS CANNOT FLY

As the caption says, microorganisms cannot fly. Microorganisms have no way of propelling themselves from one site to another. They must be carried by persons, objects or particles of matter.

Sneeze or cough: Microorganisms can be propelled through the air on secretions emitted with a sneeze or cough. Tuberculosis is a disease caused by the tubercle bacillus. This bacillus is transferred from one person to another by being made airborn when a contaminated person sneezes or coughs. Patients with tuberculosis must be kept in strict isolation which includes precautions in keeping the door to the room closed at all times and persons entering the room

wearing masks and hair coverings. Respiratory isolation also includes these precautions because microorganisms found in a patient's airway are easily made airborn when the patient sneezes or coughs.

People: Microorganisms transported by people, including medical personnel, visitors and patients is one of the most common sources of nosocomial infections. Medical personnel become contaminated while working with contaminated patients and equipment and then carry these to other patients. This process of contaminating one patient with microorganisms from another patient is called cross-contamination. Good and frequent handwashing is an essential part of prevention of microbial transfer by medical personnel. It is an essential part of good patient care and good respiratory care. Although it is impossible to sterilize the skin and hands, handwashing has been shown to be the most effective way of minimizing contamination of patients by medical personnel.

Inanimate objects: The second common source of nosocomial infections occurs when microorganisms are carried by inanimate objects such as equipment, bedbans, etc. Careful attention must be paid to the proper sterilization of equipment that could cause infection. Equipment that need not be sterile should at least be clean in order to minimize growth of any microbes on it.

Insects (Vectors): Insects, also called vectors, are less of a hospital problem than an environmental problem. Insects carry microorganisms which they deposit when they come in contact with humans. The tsitsi fly, for example, is the common carrier of malaria.

Humidifiers, such as bubble diffusion and cascade humidifiers, are sources of contamination to a much lesser extent than nebulizers. Microbes are not propelled from humidifiers since they must be carried on particles of matter. Water condensation in the tubing that occurs with some humidifiers is a site of potential contamination. Care must be taken to keep the tubing free of water by properly draining them so that the water runs out of the patient circuit and not back into the humidifier reservoir.

Question 5.

List the ways microorganisms are transported and describe an example of how each may occur in the hospital.

Check your answer on the next page.

Answer

5. The four ways microorganisms are transported and an example of each are:

   1) Sneeze or cough - a patient with a lung infection coughs and emits secretions

   2) People - a respiratory therapist fails to wash his hands after handling equipment contaminated by a patient with an infection

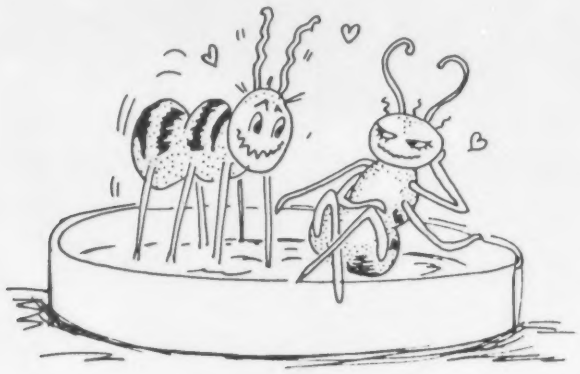
   3) Inanimate objects - an improperly sterilized endotracheal tube is inserted into a patient

   4) Insects (or Vectors) - a contaminated fly lands on a patient's open wound

NOTE: the above examples are only suggestions, your examples may be different. You will have to judge for yourself if they are correct.

CULTURING RESPIRATORY THERAPY EQUIPMENT

Culturing of equipment refers to the process of obtaining samples of potential microorganisms from equipment and sending these samples to the pathology laboratory for incubation and evaluation.



The samples are placed on a petri dish and allowed to multiply.

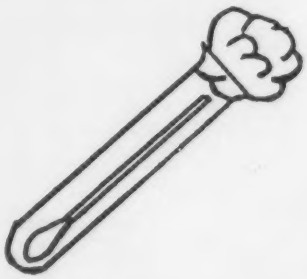
The samples are obtained under precise conditions to prevent contamination with extraneous microorganisms. There are two methods of obtaining these samples properly useful for respiratory therapy equipment.

Swab Method

The swab method is used to sample inner and outer surfaces of equipment. This method has its drawbacks when you want to sample small crevices in which the swab will not reach. For much of the sampling done in respiratory therapy, the swab method is a very adequate one.

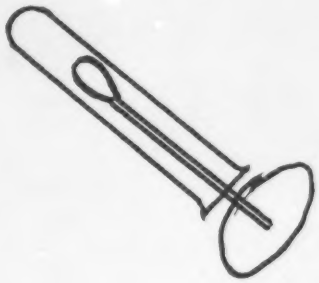
The steps in obtaining a sample by the swab method are detailed below.

NOTE: there are several pre-packaged swab culture kits available. They are used very similarly to the method to be described below, but you should read the directions on the package before attempting to use them.



1. Obtain a sterile collection tube and cotton-tipped applicator. The collection tube will have a cottonball or screw cap on it as a seal. The applicator usually comes with the collection tube as shown here.

2. Remove the cottonball or cap from the collection tube being careful not to contaminate the part that touches the inside of the tube. Do not lay the cottonball down; hold it between your first and second fingers with the part that extends inside the tube pointed away from your hand. A screw cap may be laid upside down or you may hold it in a similar manner as the cottonball.

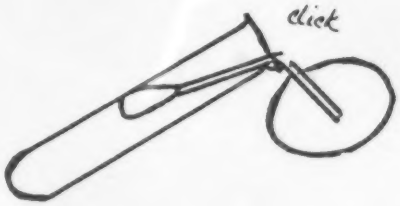


3. Remove the cotton-tipped applicator from the collection tube by turning the tube downward and gently tapping it so that the applicator slides part-way out as shown here.

4. Grasp the applicator at its end only. Be careful not to touch any other part of the applicator. Do not put the collection tube down, hold it in your hand until you are finished sampling.

5. Swab the desired area thoroughly with the cotton-tip of the applicator.

6. Insert the applicator about half-way into the collection tube. Be sure that the end of the applicator you are holding does not enter the tube. Using the edge of the tube as a fulcrum, break the applicator and let it fall into the tube as shown here.



7. Replace the cottonball or screw cap back on the collection tube.

8. Mark the specific piece of equipment, area sampled and the date sample is taken on the collection tube and send it to the pathology laboratory for incubation and evaluation.

Aerosol Method

Aerosol sampling is the most accurate method for equipment emitting an aerosol. This method is not restricted to just a few surface of the equipment. It allows sampling of all potential areas of contamination and most nearly reflects any contamination the patient may receive.

The procedure for aerosol sampling is very simple and can be performed in a short period of time. The steps are detailed below.

1. Select the equipment to be sampled. Make sure there is solution present. If you are sampling unused, sterile equipment add sterile water to the reservoir to obtain the sample.
2. Obtain a petri dish containing the properly sterilized culture medium preparation from the pathology laboratory.
3. Attach the equipment to the appropriate power source and turn it on so that the aerosol is emitting at a moderate rate.
4. Remove the petri dish cover, being careful not to touch the inside of the dish or cover.
5. Direct the aerosol about 6 inches away from the culture medium. Allow the aerosol to flow onto it for 10 seconds.
6. Replace the petri dish cover and mark it with the specific piece of equipment and the date the sample is taken. Send the sample to the pathology laboratory for incubation and evaluation.

If you are presented with a slant-tube culture vial from the pathology laboratory, an alternate procedure must be followed.

1. In addition to selecting the equipment to be sampled and obtaining the slant-tube culture vial, obtain a clean laboratory funnel.
2. Flush the funnel with the aerosol for 10 seconds to remove any contaminants in it.
3. Remove the screw cap from the culture vial and place the funnel into the mouth of the vial being certain that the funnel tip does not touch the agar.

4. Direct the aerosol into the funnel for 10 seconds.

5. Remove the funnel, replace the screw cap, mark the tube and send it to the pathology laboratory as previously described.

Question 6. List three pieces of respiratory therapy equipment you would sample by each method.

Check your answer on the next page.

Answer

6. Swab method: humidifiers
Wright and other spirometers
pulmonary function equipment
endotracheal and tracheostomy tubes
suction catheters

Aerosol method: IPPB machines and set-ups
Ventilators and circuits
Nebulizers - pneumatic and ultrasonic
mist tents

WHERE AND WHEN TO CULTURE RESPIRATORY THERAPY EQUIPMENT

Microorganisms enter the body primarily through broken skin, the digestive tract and the respiratory tract. In respiratory therapy we are concerned with entrance of microorganisms through the respiratory tract.

Ideally, any equipment that comes in contact with the respiratory tract should be sterile. But, some disposable IPPB set-ups and large bore tubing for aerosol therapy come only clean. Departmental policies dictate which equipment needs to be sterile and which clean, and how often they are changed. These policies should be established only after careful surveillance of equipment for microbial growth has been done.

Periodically, all equipment should be cultured for two reasons.

> As a check to determine whether cleaning and sterilizing procedures are adequate. Clean equipment should contain no pathogenic microbes and sterile equipment should contain no microbes at all.
>
> As a check to determine whether departmental policies (e.g. length of time between changes of equipment in use) are adequate in preventing contamination of patients or whether there are lapses in these procedures which are sources of contamination.

Question 7.

Your department's policy is to change heated nebulizers every 2 days and you suspect that this is not often enough. How should you prove that your suspicions are true and how would you determine for certain the correct length of time between changes?

Answer

7. You should culture several heated nebulizers that are in use at regular intervals, e.g. every 8 hours, for the two-day period. If microbes are detected in any sample, the policy is inadequate. The correct length of time between changes will be the amount of time passed before a positive culture was found. For example, if your first positive culture occurrred after 24 hours of use, then the nebulizers should be changed at least every 24 hours or even less.

Sampling sites for equipment culturing should be sites that are potential sources of contamination to the patient. They should be chosen on the basis of where microbes are most likely growing. Likely places to sample include: (1) baffles and crevices within the flow of aerosol because microbes carried in a flow of aerosol tend to remain on surfaces they encounter, (2) small crevices and corners where they can grow undisturbed, and (3) wherever there is moisture, especially if it is heated.

A SYSTEM OF BACTERIAL SURVEILLANCE

There are four requirements of a system of bacterial surveillance. First, the system should be well-planned and organized. Second, it should be a routine part of the departmental procedures. Third, the information received should be carefully recorded. And fourth, there should be appropriate follow-up on the results.

Well-planned and organized

A system for bacterial surveillance should be a well-planned and organized system. Careful thought must go into how surveillance procedures will be done and these should be explicitly written in a procedure policy manual. All Staff members must be made aware of the procedures, for example by inservice sessions. Lapses in procedure should be determined and corrected quickly.

Routine

A system for bacterial surveillance should be a routine part of the department. Haphazardly culturing random equipment leaves many holes in the system. All equipment should be cultured in a given period of time. And, culturing should be done on a routine basis by designated staff members. "Ms. So-and-So, why don't you culture some equipment today?" will not do.

Record

A system for bacterial surveillance must contain records of all pertinent information. The results of all cultures done and follow-up on positive cultures must be recorded in a log. The occurrence of any

suspicious patient infections and follow-up on these should be recorded.

Follow-up

A system of bacterial surveillance should include appropriate follow-up procedures and these should be tenaciously adhered to.

When culturing equipment to check sterilization and cleaning procedures, all items in the batch with the items cultured should be set aside and not used while waiting for the culture results. If all cultures come back negative, then the equipment can be released and used. If, however, even one culture comes back positive, the whole batch must be re-processed. It can be assumed that a positive culture of newly sterilized equipment means other batches are likewise contaminated. Since some of this equipment has already been used, nothing can be done to prevent its use. The epidemiology nurse must be notified immediately since this is a very serious matter. A full-scale effort must be launched to determine the source of contamination. Lapses in technique must be rectified and if no lapses are found, sterilization procedures must be upgraded. Before any equipment is used cultures should be done again to be sure that there is no longer any contamination.

Positive cultures on equipment in use should be followed-up as well. Lapses in procedure and/or inadequate policy should be corrected at once.

Question 8.

Describe the four components of an effective system of bacterial surveillance and why each is important.

Answer

8. The four components of a system of bacterial surveillance include:

   A. Well-planned and organized - so that important areas are not overlooked and everyone knows these procedures.

   B. Routine - so that procedures will be done on a regular basis.

   C. Record - so that results and follow-up are documented.

   D. Follow-up - so that action is taken to correct and prevent the occurrence of positive cultures.

Post-test

1. Define bacterial surveillance in your own words.

Place the letter of the correct answer in the space provided to the left of each question. There is only ONE correct answer to each question.

____ 2. Bacteria thrive in what type of environment?
   a. cold and wet
   b. cold and dry
   c. warm and wet
   d. warm and dry

_____ 3. Which of the following is the least likely place to find growing microorganisms?
   a. a heated nebulizer in continuous use on a patient with a tracheostomy
   b. the exhalation valve on an IPPB circuit being used by a patient for a treatment
   c. Inside the small bore tubing on an oxygen mask being used to deliver 6 lpm of oxygen to a patient
   d. inside a Wright spirometer being used to measure several patients' minute volumes

_____ 4. The infection of a patient with a microorganism from another patient is called:
   a. transfer by fomites
   b. cross-contamination
   c. contra-sepsis
   d. infectious contamination

_____ 5. Which of the following statements is NOT true regarding hand-washing?
   a. Frequent handwashing has been shown to prevent cross-contamination.
   b. Good handwashing insures hand sterility.
   c. Good handwashing is a very important part of hospital asepsis.
   d. Good and frequent handwashing is an essential part of optimal respiratory care.

_____ 6. Microorganisms may be carried to patients in all of the following ways except:
   a. a sneeze or cough
   b. hospital personnel
   c. inanimate objects
   d. on their own power

7. In general, what equipment should be cultured and when?

8. Five out of six random cultures on equipment freshly sterilized came back positive. The organism cultured was Staphylococcus aureus. What should you do at this point?

9. In the situation in question #8 above, would the situation be as serious if only one culture was positive? Explain.

10. Outline the procedures for culturing equipment by the two methods described in the text of this package and give an example of a piece of equipment you culture by each method.

11. Describe the four components of an effective system of bacterial surveillance and why each is important.

Post-test Answer Key

1. Bacterial surveillance is the act of watching, by indirect methods, for the growth of microorganisms.

2. c

3. c

4. b

5. b

6. c

7. Equipment that comes in contact with the patient's respiratory tract should be cultured periodically to determine if sterilization or cleaning procedures and departmental policies are adequate in preventing contamination.

8. Since sterilization is not being achieved by the method being used, an alternate method should be initiated. In the meantime, no equipment should be used until the new method is established and checked out to be effective.

9. Yes, the situation would be just as serious because the presence of even one microorganism means that the equipment is contaminated, i.e., sterilization was not achieved.

10. Swab method:
    a. obtain necessary culture vial and sterile swab
    b. remove swab being certain to touch it only at the tip of the stick
    c. swab area to be sampled
    d. replace swab in vial breaking off end that was touched and allow the remainder to fall into the vial.
    e. replace vial cap or cottonball, label appropriately and send to pathology lab.

    Equipment such as humidifiers, spirometers, pulmonary function equipment, endotracheal and tracheosto y tubes, and suction catheters may be sampled by this method.

    Aerosol method:
    a. operate approprate equipment so that an aerosol is being emitted
    b. direct the aerosol about 6 inches from petri dish and allow the aerosol to be deposited on the agar for approximately 10 seconds.
    c. replace petri dish cover, label and send to pathology lab.

    Equipment such as IPPB machines, ventilators, nebulizers and mist tents may be sampled by this method.

11. The four components of a system of bacterial surveillance include:

    a. Well-planned and organized - so that important areas are not overlooked and everyone knows the procedures.

    b. Routine - so that procedures will be done on a regular basis

    c. Record - so that results and follow-up are documented.

    d. Follow-up - so that action is taken to correct and prevent the occurrence of positive cultures, indicating contamination is present.

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